# OscSNS: A Precision Neutrino Oscillation Experiment at the SNS

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There is growing evidence for short-baseline neutrino oscillations and the possible existence of sterile neutrinos. Such non-standard particles, first invoked to explain the LSND $\bar{\nu}_\mu \to \bar{\nu}_e$ appearance signal, would require a mass of $\sim 1$ eV/c$^2$, far above the mass scale associated with the active neutrinos. More recently, the MiniBooNE experiment has reported a $3.8\sigma$ excess of events consistent with the LSND appearance signal. In addition, lower than expected neutrino-induced event rates from calibrated radioactive sources and nuclear reactors, and the preference for more than three relativistic degrees of freedom from cosmology analyses, can also be explained by the existence of sterile neutrinos. Fits to the world neutrino and antineutrino data are consistent with sterile neutrinos at this $\sim 1$ eV/c$^2$ mass scale, though there is some tension between measurements from disappearance and appearance experiments. It should now be established whether such totally unexpected light sterile neutrinos exist.

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, built to usher in a new era in neutron research, provides a unique opportunity for US science to perform a definitive search for sterile neutrinos. The 1.4 MW beam power of the SNS is a prodigious source of neutrinos from the decay of $\pi^+$ and $\mu^+$ at rest. These decays produce a well specified flux of neutrinos via $\pi^+ \to \mu^+\nu_\mu$, $\tau_\pi = 2.7\times10^{-8}$ s, and $\mu^+ \to e^+\nu_e\bar{\nu}_\mu$, $\tau_\mu = 2.2 \times 10^{-6}$ s. The SNS low duty factor ($\sim 695$ ns beam pulses at 60 Hz, $DF = 4.2 \times 10^{-5}$) is more than 1000 times less than LAMPF, and this smaller duty factor reduces cosmic backgrounds and allows the $\nu_\mu$ induced events from $\pi^+$ decay to be separated from the $\nu_e$ and $\bar{\nu}_\mu$ induced events from $\mu^+$ decay. The OscSNS detector will be based on the LSND and MiniBooNE detectors and will consist of an 800-ton tank of mineral oil, covered by approximately 3500 8-inch phototubes, and located about 60m from the SNS target. The experiment will use the monoenergetic 29.8 MeV $\nu_\mu$ to investigate the existence of light sterile neutrinos via the neutral-current reaction $\nu_\mu C \to \nu_\mu C^*(15.11 \text{ MeV})$, which has the same cross section for all active neutrinos but is zero for sterile neutrinos. An oscillation of this reaction, with a known neutrino energy, is direct evidence for sterile neutrinos. OscSNS can also carry out a unique and decisive test of the LSND appearance $\bar{\nu}_\mu \to \bar{\nu}_e$ signal. In addition, OscSNS can make a sensitive search for $\nu_e$ disappearance by searching for oscillations in the detector of the reaction $\nu_e C \to e^- N_{gs}$, where the $N_{gs}$ is identified by its beta decay. It is important to note that all of the cross sections involved are known to a few percent or better.

The existence of light sterile neutrinos would be the first major extension of the Standard Model, and sterile neutrino properties are central to dark matter, cosmology, astrophysics, and future neutrino research. OscSNS would be able to prove whether sterile neutrinos can explain the existing short-baseline anomalies.